FIG. 1

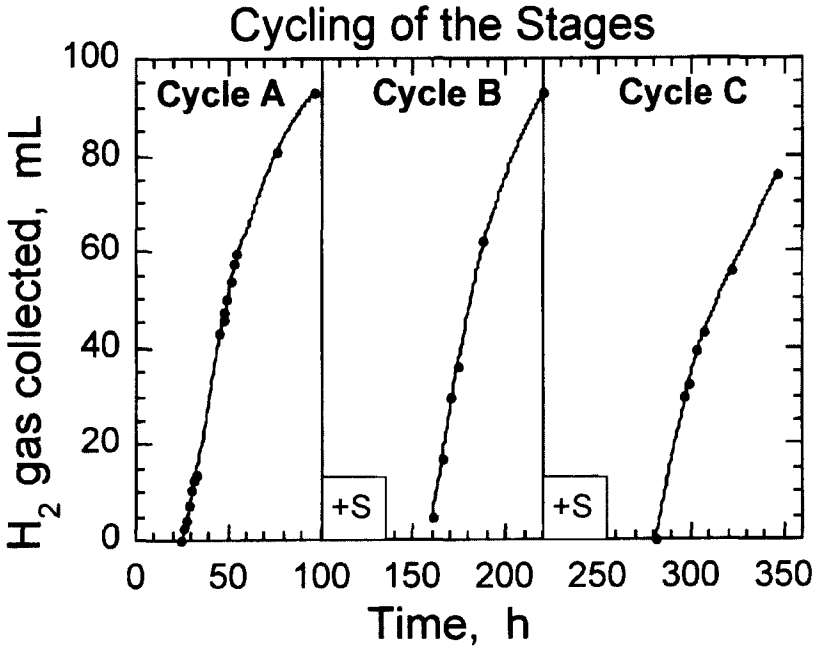

Cycling of the Stages
Cycle A
Cycle B
Cycle C
+S
+S
H_2 gas collected, mL
Time, h
0
20
40
60
80
100
0
50
100
150
200
250
300
350

FIG. 2

Chlamydomonas reinhardtii chloroplast Sulfate Permease (*SulP*) gene structure

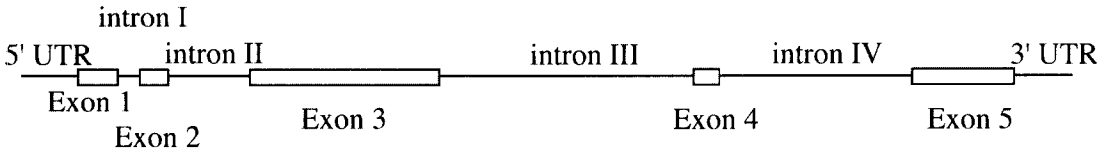


FIG. 3

reinhardtii chloroplast Sulfate Permease *(SulP)* amino acid sequence

MERVCSHQLASSRGRPCIAGVQRSPIRLGTSSVAHVQVSPAGLGRYQRQRLQVVASAAAA
AAFDPPGGVSAGFSQPQQQLPQQHPRQPQAVAEVAVAESVSAPASAAPSNDGSPTASMDG
GPSSGLSAVPAAATATDLFSAAARLRLPNLSPIITWTFMLSYMAFMLIMPITALLQKASL
VPLNVFIARATEPVAMHAYYVTFSCSLIAAAINCVFGFVLAWVLVRYNFAGKKILDAAVD
LPFALPTSVAGLTLATVYGDEFFIGQFLQAQGVQVVFTRLGVVIAMIFVSFPFVVRTMQP
VMQEIQKEMEEAAWSLGASQWRTFTDVVLPPLLPALLTGTALAFSRALGEFGSIVIVSSN
FAFKDLIAPVLIFQCLEQYDYVGATVIGTVLLLISLVMMLAVNQLQKLARK* (SEQ ID NO:1)

FIG. 4A

Coding sequence of CrcpSulP

5' UTR:173 bp, Exon1: 124 bp, intronI: 77 bp, Exon2: 78 bp, intronII: 279 bp Exon3: 620 bp, intronIII: 834 bp, Exon4: 87 bp, intronIV: 699 bp, Exon5: 327 bp, 3'UTR: 575 bp

Total length: 3873 bp

```
gcttagtacc taagcaaaaa taccaaagcc ttatcctgag ttgtcaacaa gaactccagc 60
ctgcgacgat gcaaagcctt tcttgagcgg gttgatggac tttgctttgt tatctgtcca 120
gtaagccacc agacactacc aagtagagta atccatttgt ataggtacag aatatggagc 180
gagtttgcag ccatcagctt gcctcgtcgc gagggaggcc atgcatcgct ggggtgcagc 240
ggtcgcccat ccgactaggg acttcaagcg ttgctcatgt gcaggtctct ccggcaggta 300
agcaccgcgc tcggcggcgt gtacacatgg ggccgtcagg ccaactgcgt ttgttggcta 360
tgcaaccgaa acaggccttg ggagatatca acggcaaaga ctgcaagtcg tggcgtctgc 420
agctgcggca gcggctttcg accctcctgg aggtgcgtgg cgtgagggct gcacgggtgc 480
gggttggcct ggaaaccaag cctcgccacg actacctgca acagcattgc ccgcatctcc 540
agcccctcac cctcgagtgc ctcccgaaga cctctatccc ctgcgcatca ttggttcggg 600
ggcgccgcct gcgggccttg ggcgctggct acgctgaccg cacggcacga cttggcacgg 660
cctggcgcgg cctgagcggc ccccccctc ctgatggccc cacgctttgc cgcccacgcc 720
gctccccgca ggtgtctccg ccgggttctc gcagccgcaa cagcagctgc cacaacagca 780
cccacgccaa ccacaggcgg tggcggaggt agctgtcgcc gagtcagtct cggcgcccgc 840
ttctgcggcg ccctccaatg atggctcgcc cacggcctcc atggacggcg gccccagctc 900
cggcctcagc gccgtgcccg ccgccgccac cgccaccgac ctcttctccg ccgcggcgcg 960
cctccgcctg cccaacctct cccccatcat cacctggacc ttcatgctct cctacatggc 1020
cttcatgctc atcatgccca tcaccgcgct gctgcaaaaa gcctcgctcg tgccgctcaa 1080
cgtcttcatc gcgcgcgcca ccgagccggt ggcgatgcac gcctactacg tcaccttctc 1140
ctgctcgctg atcgcggccg ccatcaactg cgtgtttggc ttcgtgctgg cctgggtgct 1200
ggtgcgctac aatttcgcgg ggaagaagat cctggacgcg gcggtggacc tgccgttcgc 1260
gctgccgacc tcggtggcgg gcctcacgct tgccacggtg tacggcgacg agttcttcat 1320
cggccagttc ctgcaggcgc agggcgtgca ggtgcgtgcg tatagcatag tggagtgtgg 1380
ttagcagctg ggggtccggc agtagttccc gccctagtga ggtcgaaact ataccagaag 1440
aagaggacga acatggggct atccagcaag ctcgtctagg gaaggaggag tttgggagaa 1500
cggtggggtg ggagggagag ggagggcgtt ggctgggagg gaagggtaag gcgggaggga 1560
gatggtagca cggggcgttg gggacgcaga aggatgacag gcggctgcag ggaagggatg 1620
gggaagcgga gctggggaca gtgcgaagag ccgggagaga ggggaagttt gagtcaggaa 1680
gaggggctag agaggggcat gcggactcct gctgggattt aggtgcgtgc tcattgagga 1740
gcccttggaa tcagcggacg gaaacgtggc cgacggggtc tgccgagcac accaggctag 1800
ctagacgcgc ggttgggcaa cgagcagagc tgctgtgcgg ctatggatgg aaggcgatgc 1860
agcgagcatg tgcagtgaac attggtttga ggacagggga ctccgaggtt gcataggcgg 1920
gccgccactg tctctgccgc tagggtgact agctgcctcg aacctggcgg tggccccata 1980
cccgcagttg gaggatgctc cacgcgcttc agcttgccat gtctggggtc tgggtctgga 2040
cgcaatcagc gtgtgagggt ccaactctat atggaattat ggataccttc caactaccag 2100
cacgtaggct gccggaacgc ggctgaagcg gctggcctgc cccctcatcc tctcgttccc 2160
```

FIG. 4B

ctgtttttgt cccctgtcca cccaggtggt gttcacgcgg ctgggtgtgg tgatcgccat 2220
gatcttcgtg tccttccccc tcgtggtgcg caccatgcag cccgtcatgc aggtgagagc 2280
gcccaggagg cggagccatg gcgggttggg gcgggttggg gcgggttggg gcggggcgcg 2340
gatggggcgg cttggggagt aatgtggggc ggatggggtg gcagcctggc agggtatggg 2400
agcgagagga tagcggggac aggggacagg gaagggaagg gaaggggaag gatgccctat 2460
gcgagcaaag ggggtatggg aaccggcggt tggggctggg agcgacggga gcagggaggg 2520
agtgcacgga acgggggcaa ggcggacagg gtgagggagg gtgcaggccg gactgggatg 2580
ggtcatgtgt cctggtcggg ggtgtagccg tgggaggcgg gcaggcagcg tgtgttctgg 2640
cacggtgttt tggcgaaaga taccacggca tggtatgggg ccagttgggc agggaagaac 2700
cgttggacac gacttcgttg acagatctag ttcattgcac ccgggtcgca ccaagggtgg 2760
cggcgagccc ggcccggcac gtccgagtac cccggagccg taacgccgca acccgccttg 2820
ttgcgccccc tccctgctcc cctgctccgc ataccgtgca ccatgccctc tgccgccccc 2880
tcaggccctc aggccctcac ctccccctca cctcctccta acgccttccc ctcgccttcc 2940
cttcccctcc caacgccacc acgtgcaaca ggaaatccaa aaggagatgg aggaggcggc 3000
atggtcgctg ggcgcctcgc agtggcgcac cttcacagac gtggtgctgc cgccgctgct 3060
gcccgcgctg ctgaccggca cggcactggc cttctcgcgc gcgcttggcg agttcggatc 3120
cattgtcatc gtgtcctcca actttgcctt caaggacctg atcgcgcccg tgctgatctt 3180
ccagtgcctg gagcagtacg actacgtggg cgccaccgtg atcggcacag tactgctgtt 3240
gatttcgctg gtgatgatgt tggcggtgaa ccagctgcag aagctggcgc gcaagtgagg 3300
ggctgaggcg tttgaggaga gtgggcgtct gcggaggcgc ttgtggcgca ggggcaggtg 3360
gaggaggttg cagggtgagg caggagtggc aggtggtgga gggtgcaggg cggggtgttg 3420
ggatgggatg ggatgggacc gtgggagggg tgggactttg ggtgggtggg agtgggtgct 3480
acgtattagg atatgggagg tggtatgcag ttgaaggggg gggtggcaat ctggacgggg 3540
actcactgtt tactaggcac gcatgtcgca ggagtggata tcgatgggtg tggggatgtc 3600
agcacgcttg gcttgagttg ggccatggga cccgggacta ggcttggttg cgagccgagc 3660
cagtcaccag ggagacgtac gagcgcacac agtgattacg gggattgatt aggcggcgaa 3720
ttgacgcaaa tccacggggg ctgtggcttg ggggaggcag ggattgagcg aaggacgcac 3780
tgcaagctca ggcagtcgca tgcccgtacc ctgcttctgg tccagtgtgg agacaagact 3840
ggcaatcgtg gtcctttgca attcatggcg cgc (SEQ ID NO:2)

FIG. 5

Full length cDNA sequence of *CrcpSulP*: 1984 bp

```
gcttagtacc taagcaaaaa taccaaagcc ttatcctgag ttgtcaacaa gaactccagc 60
ctgcgacgat gcaaagcctt tcttgagcgg gttgatggac tttgctttgt tatctgtcca 120
gtaagccacc agacactacc aagtagagta atccatttgt ataggtacag aatatggagc 180
gagtttgcag ccatcagctt gcctcgtcgc gagggaggcc atgcatcgct ggggtgcagc 240
ggtcgcccat ccgactaggg acttcaagcg ttgctcatgt gcaggtctct ccggcaggcc 300
ttgggagata tcaacggcaa agactgcaag tcgtggcgtc tgcagctgcg gcagcggctt 360
tcgaccctcc tggaggtgtc tccgccgggt tctcgcagcc gcaacagcag ctgccacaac 420
agcacccacg ccaaccacag gcggtggcgg aggtagctgt cgccgagtca gtctcggcgc 480
ccgcttctgc ggcgccctcc aatgatggct cgcccacggc ctccatggac ggcggcccca 540
gctccggcct cagcgccgtg cccgccgccg ccaccgccac cgacctcttc tccgccgcgg 600
cgcgcctccg cctgcccaac ctctccccca tcatcacctg gaccttcatg ctctcctaca 660
tggccttcat gctcatcatg cccatcaccg cgctgctgca aaaagcctcg ctcgtgccgc 720
tcaacgtctt catcgcgcgc gccaccgagc cggtggcgat gcacgcctac tacgtcacct 780
tctcctgctc gctgatcgcg gccgccatca actgcgtgtt tggcttcgtg ctggcctggg 840
tgctggtgcg ctacaatttc gcggggaaga agatcctgga cgcggcggtg gacctgccgt 900
tcgcgctgcc gacctcggtg gcgggcctca cgcttgccac ggtgtacggc gacgagttct 960
tcatcggcca gttcctgcag gcgcagggcg tgcaggtggt gttcacgcgg ctgggtgtgg 1020
tgatcgccat gatcttcgtg tccttccgct tcgtggtgcg caccatgcag cccgtcatgc 1080
aggaaatcca aaaggagatg gaggaggcgg catggtcgct gggcgcctcg cagtggcgca 1140
ccttcacaga cgtggtgctg ccgccgctgc tgcccgcgct gctgaccggc acggcactgg 1200
ccttctcgcg cgcgcttggc gagttcggat ccattgtcat cgtgtcctcc aactttgcct 1260
tcaaggacct gatcgcgccc gtgctgatct tccagtgcct ggagcagtac gactacgtgg 1320
gcgccaccgt gatcggcaca gtactgctgt tgatttcgct ggtgatgatg ttggcggtga 1380
accagctgca gaagctggcg cgcaagtgag gggctgaggc gtttgaggag agtgggcgtc 1440
tgcggaggcg cttgtggcgc aggggcaggt ggaggaggtt gcagggtgag gcaggagtgg 1500
caggtggtgg agggtgcagg gcggggtgtt gggatgggat gggatgggac cgtgggaggg 1560
gtgggacttt gggtgggtgg gagtgggtgc tacgtattag gatatgggag gtggtatgca 1620
gttgaagggg ggggtggcaa tctggacggg gactcactgt ttactaggca cgcatgtcgc 1680
aggagtggat atcgatgggt gtggggatgt cagcacgctt ggcttgagtt gggccatggg 1740
acccgggact aggcttggtt gcgagccgag ccagtcacca gggagacgta cgagcgcaca 1800
cagtgattac ggggattgat taggcggcga attgacgcaa atccacgggg gctgtggctt 1860
gggggaggca gggattgagc gaaggacgca ctgcaagctc aggcagtcgc atgcccgtac 1920
cctgcttctg gtccagtgtg gagacaagac tggcaatcgt ggtcctttgc aattcatggc 1980
gcgc                                                              1984
```

(SEQ ID NO: 3)

FIG. 6

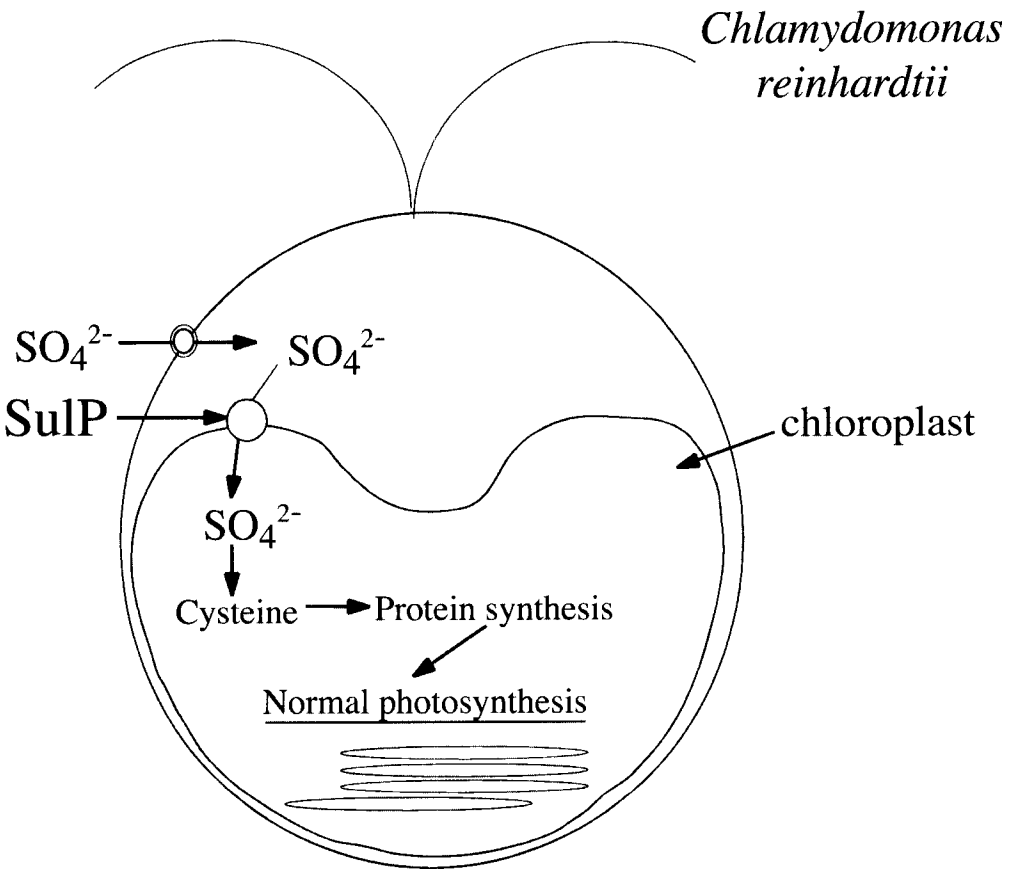

Chlamydomonas reinhardtii
SO_4^{2-}
SO_4^{2-}
SulP
chloroplast
SO_4^{2-}
Cysteine
Protein synthesis
Normal photosynthesis

FIG. 7A

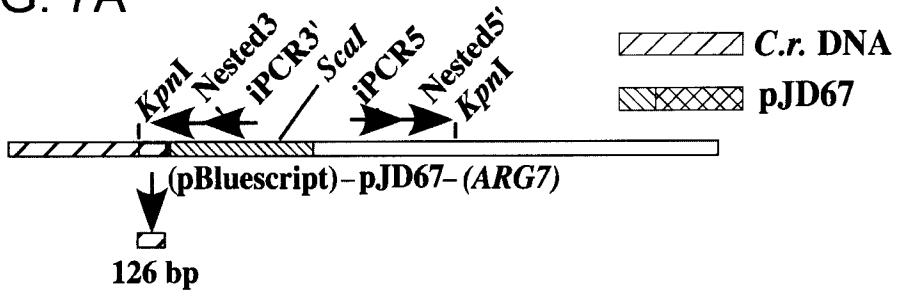

KpnI
Nested3'
iPCR3'
ScaI
iPCR5'
Nested5'
KpnI
C.r. DNA
pJD67
(pBluescript)–pJD67–(ARG7)
126 bp

FIG. 7B

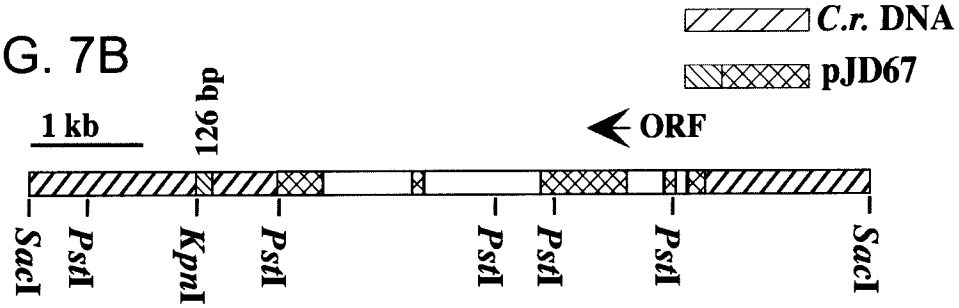

C.r. DNA
pJD67
1 kb
126 bp
ORF
SacI
PstI
KpnI
PstI
PstI
PstI
PstI
SacI

FIG. 8A

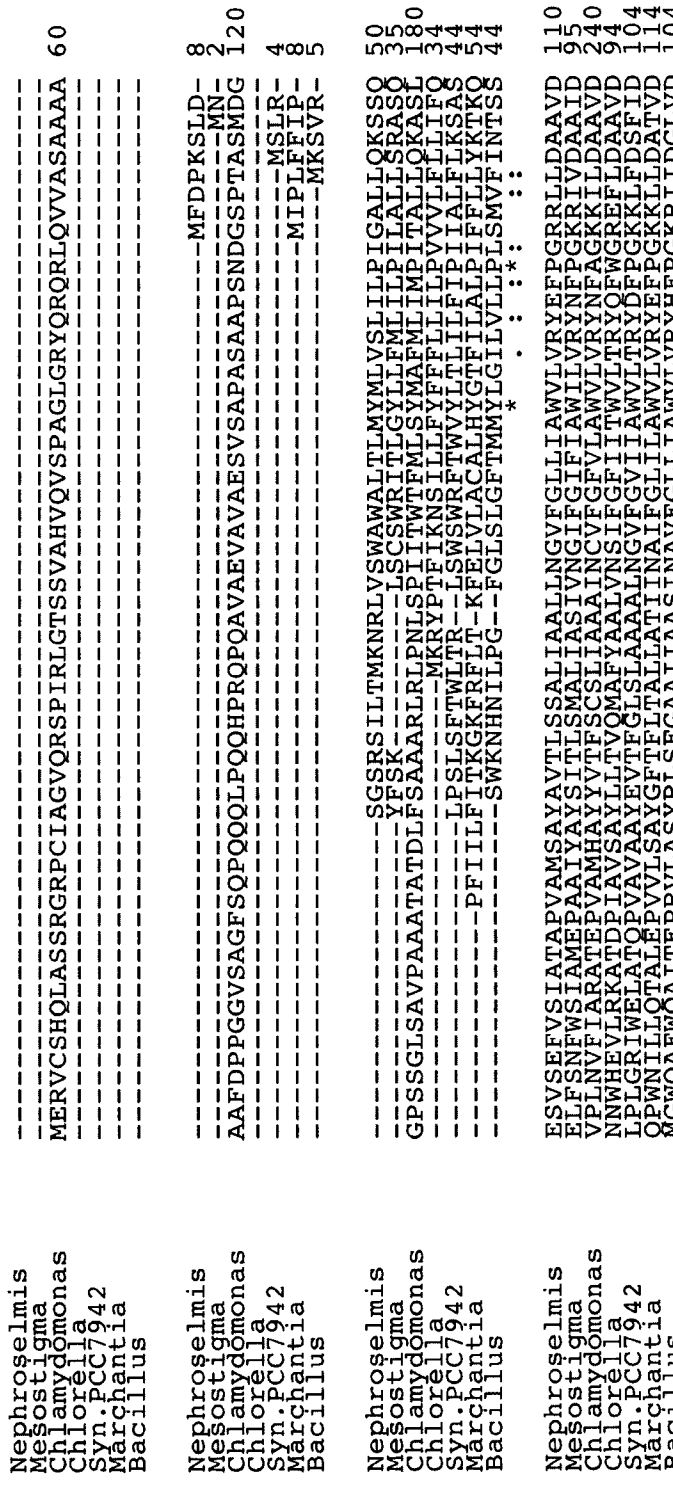


FIG. 8A
CONT.

REPLACEMENT SHEET

FIG. 8B

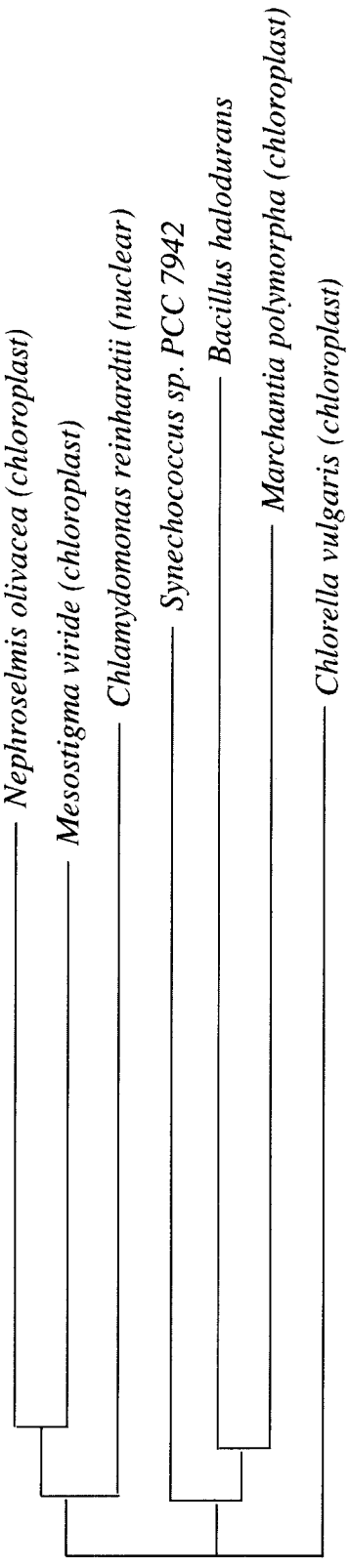

Nephroselmis olivacea (chloroplast)
Mesostigma viride (chloroplast)
Chlamydomonas reinhardtii (nuclear)
Synechococcus sp. PCC 7942
Bacillus halodurans
Marchantia polymorpha (chloroplast)
Chlorella vulgaris (chloroplast)

FIG. 9

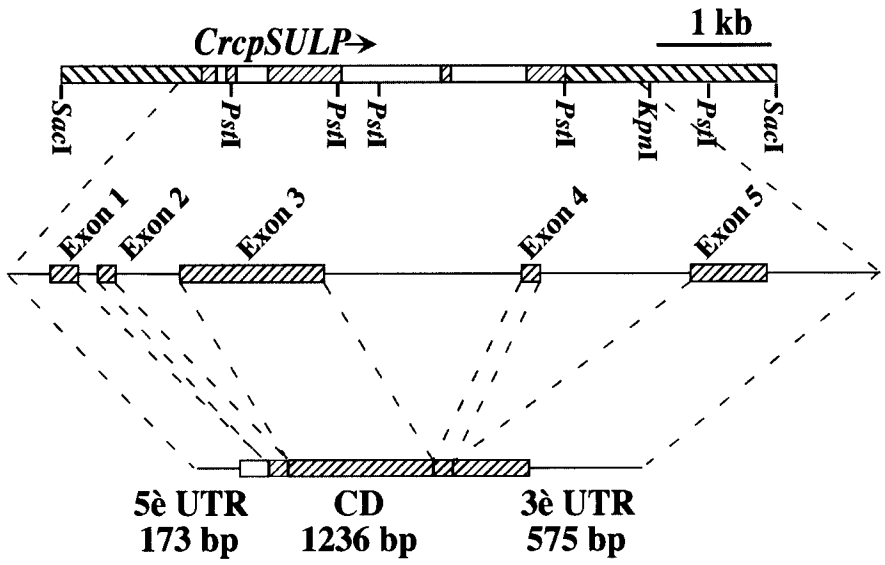

CrcpSULP
1 kb
SacI
PstI
PstI
PstI
PstI
KpnI
PstI
SacI
Exon 1
Exon 2
Exon 3
Exon 4
Exon 5
5è UTR
173 bp
CD
1236 bp
3è UTR
575 bp

FIG. 10

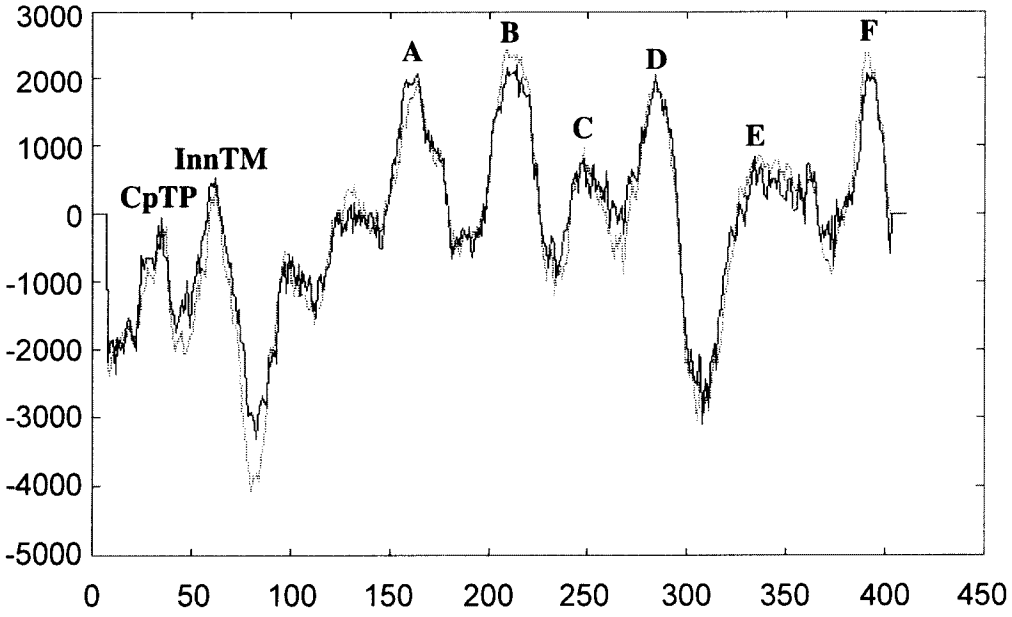

3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
0
50
100
150
200
250
300
350
400
450
CpTP
InnTM
A
B
C
D
E
F

FIG. 11A

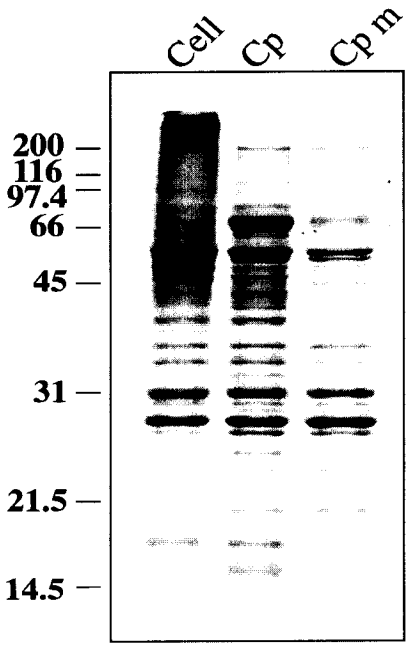


FIG. 11B

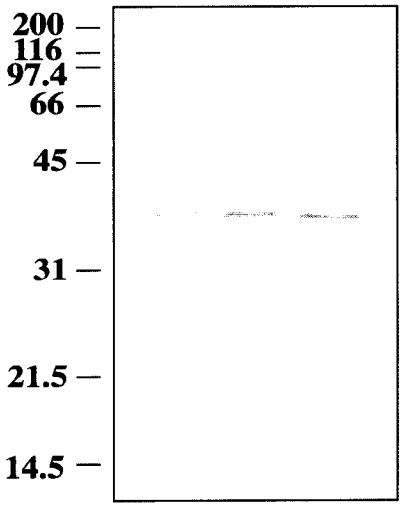


FIG. 12A

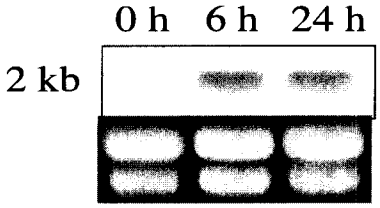


FIG. 12B

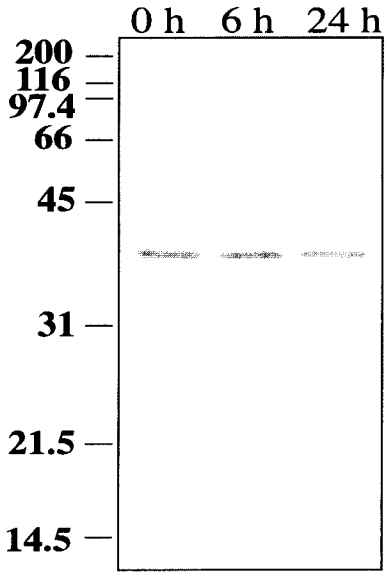


FIG. 13

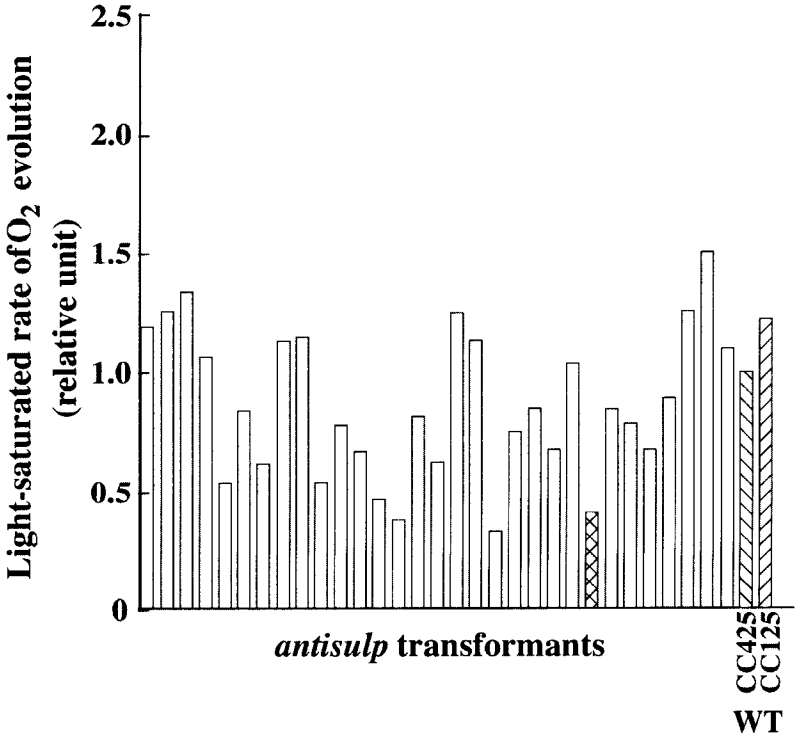

2.5
2.0
1.5
1.0
0.5
0
Light-saturated rate of O_2 evolution (relative unit)
antisulp transformants
CC425
CC125
WT

FIG. 14A

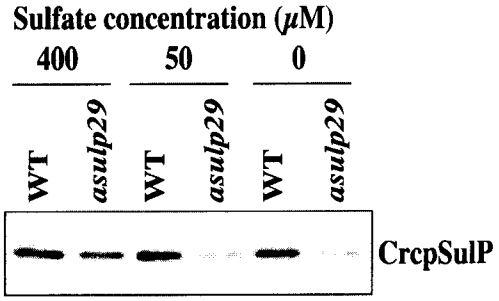


FIG. 14B

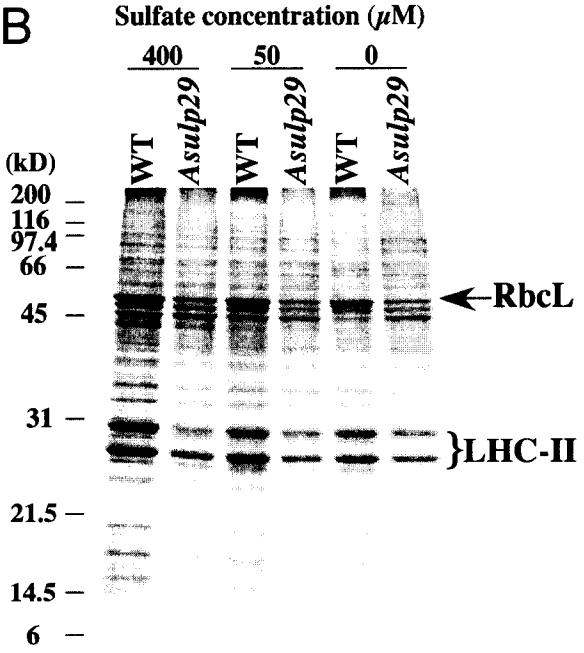


FIG. 14C

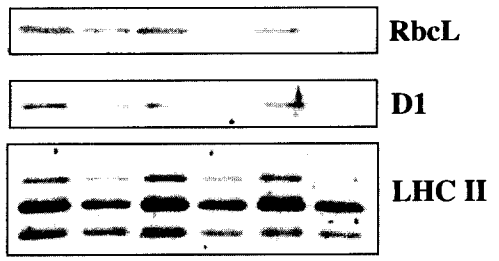


FIG. 15A

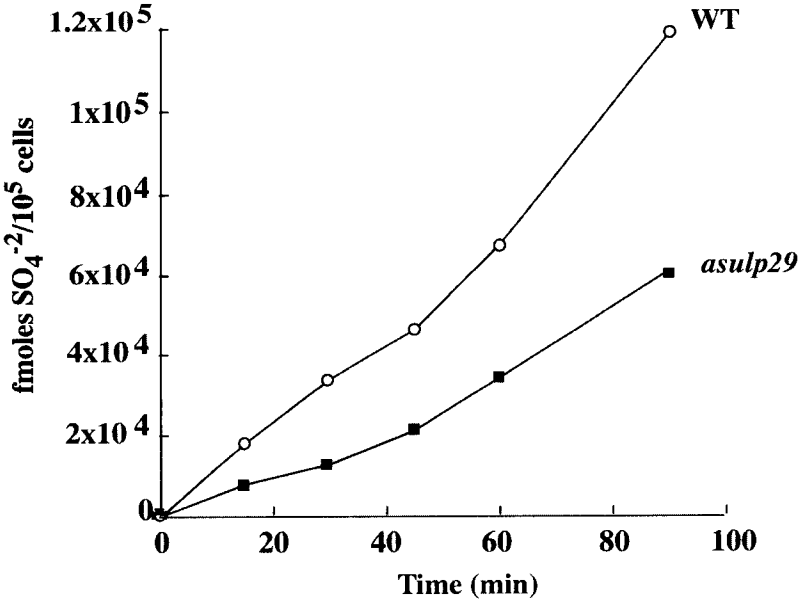
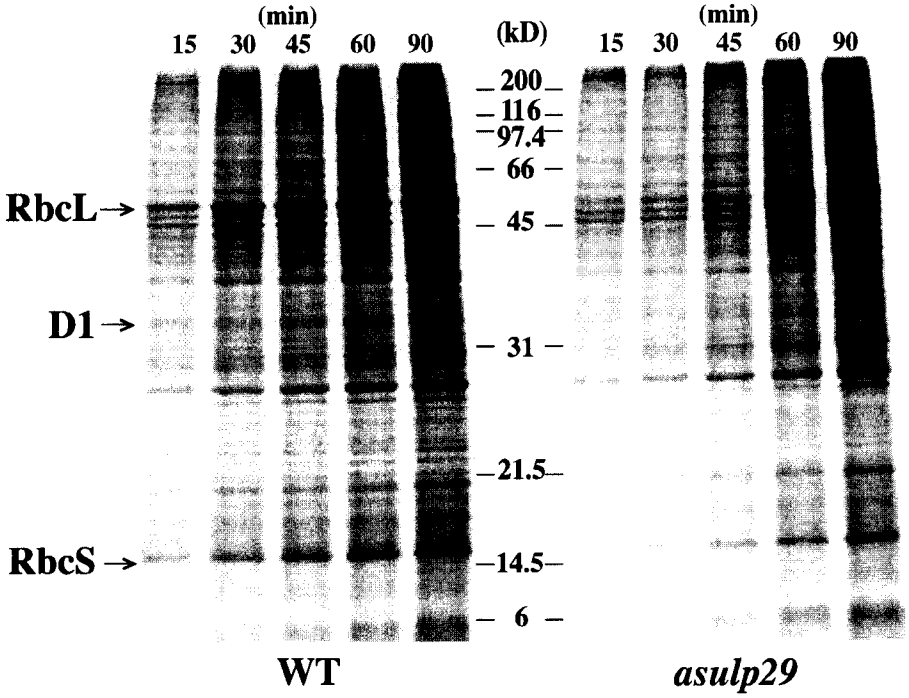


FIG. 15B



400 μM S
(TAP, S_{400})

150 μM S
(TAP, S_{150})

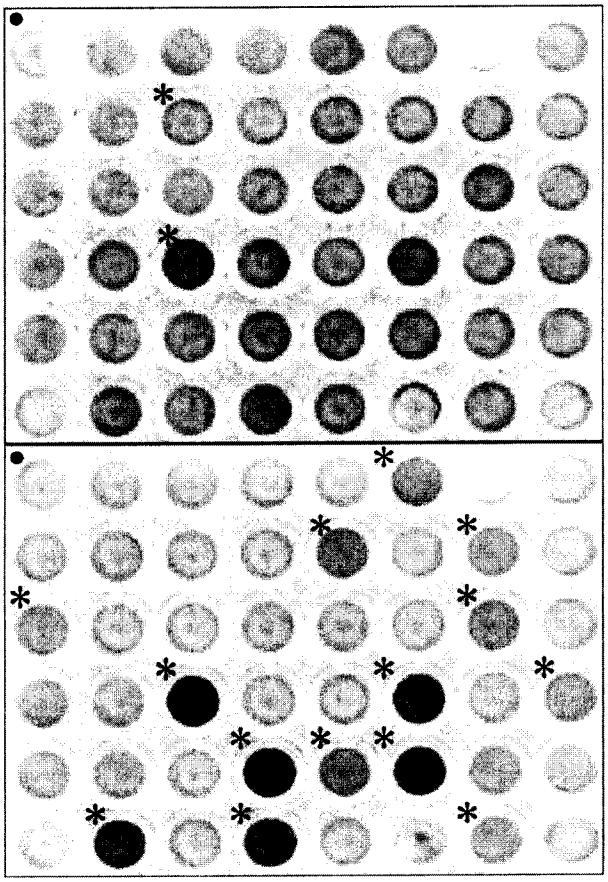


FIG. 16

FIG. 17

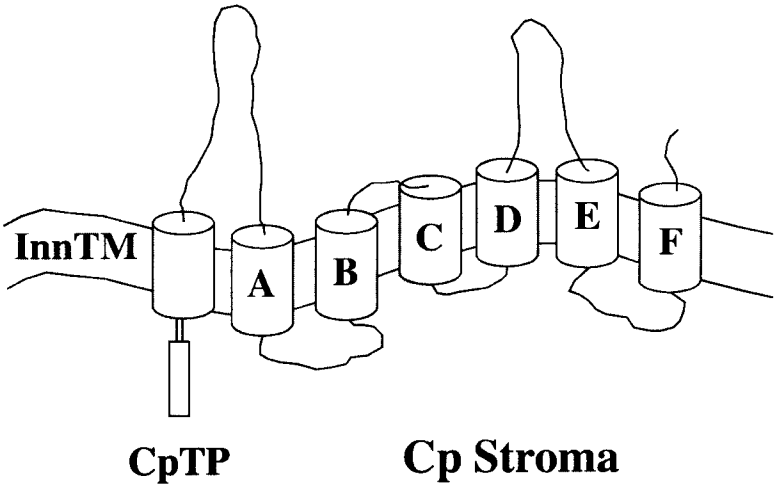


FIG. 18A

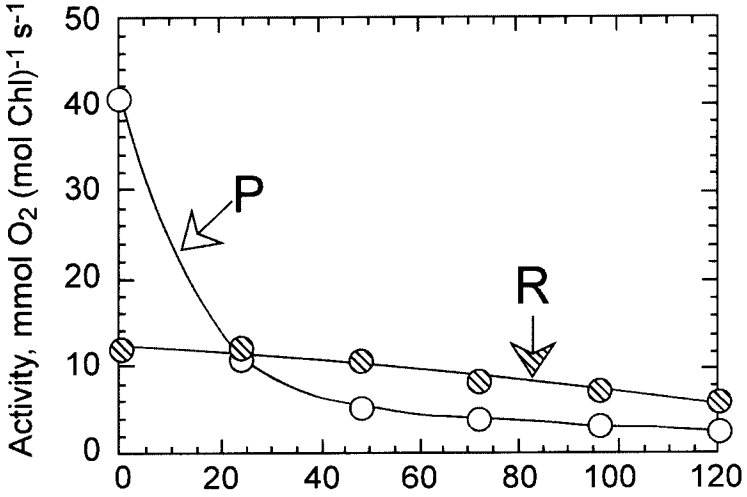


FIG. 18B

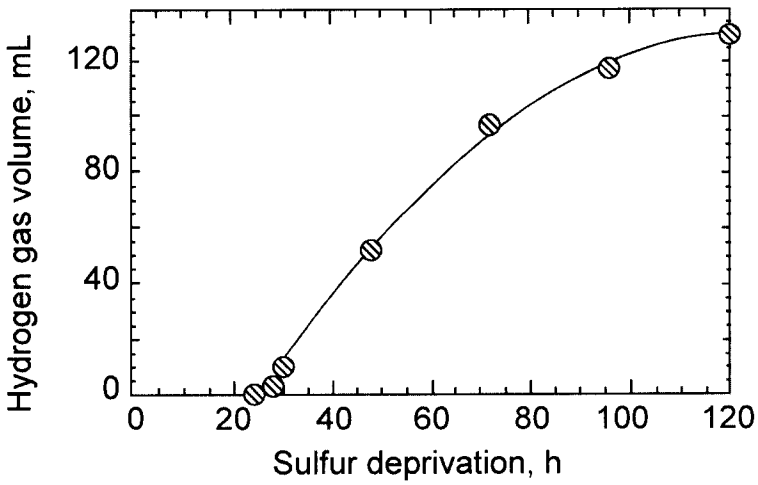


FIG. 19

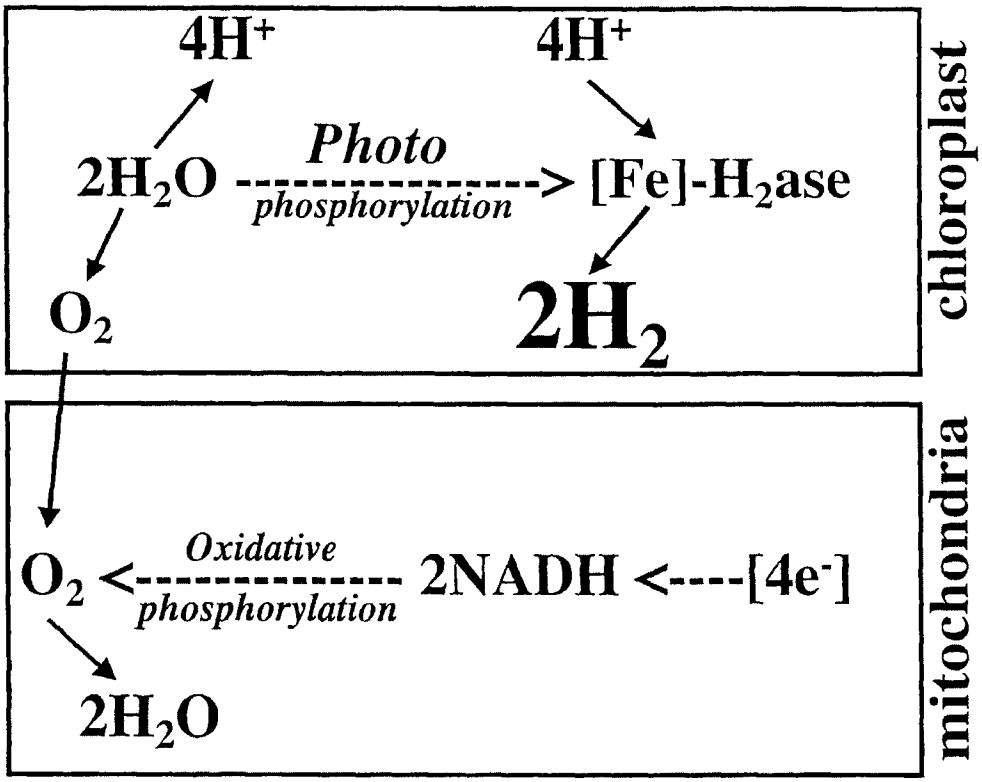
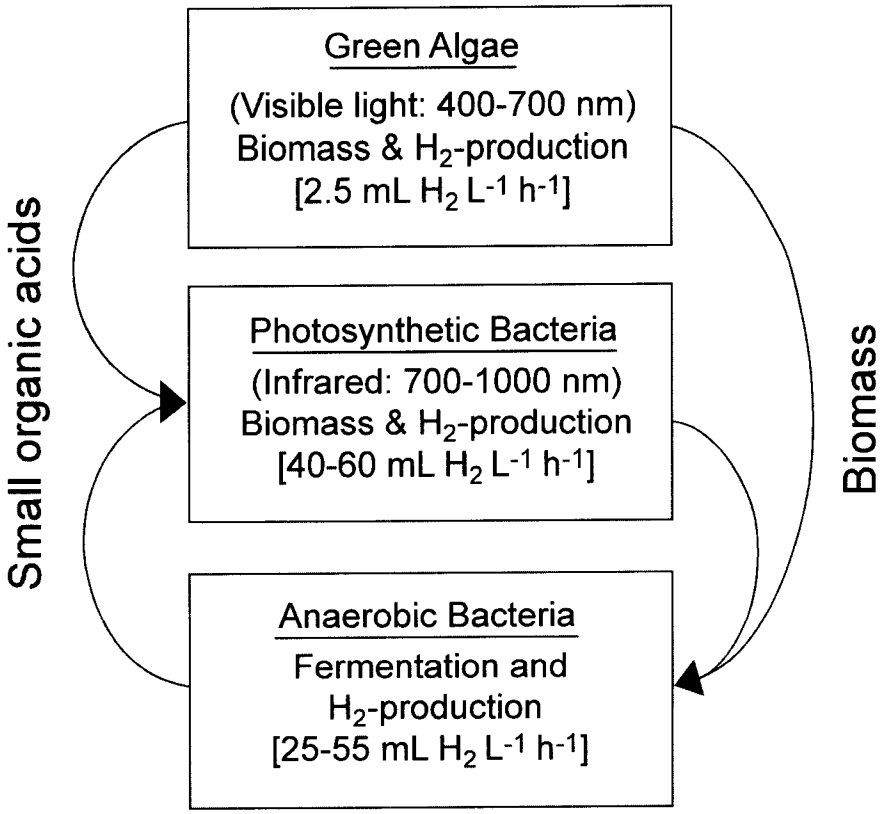

4H+
4H+
2H2O
Photo
phosphorylation
[Fe]-H2ase
O2
2H2
chloroplast
O2
Oxidative
phosphorylation
2NADH
[4e-]
2H2O
mitochondria

FIG. 20


Green Algae
(Visible light: 400-700 nm)
Biomass & H_2-production
[2.5 mL H_2 L^{-1} h^{-1}]
Photosynthetic Bacteria
(Infrared: 700-1000 nm)
Biomass & H_2-production
[40-60 mL H_2 L^{-1} h^{-1}]
Anaerobic Bacteria
Fermentation and
H_2-production
[25-55 mL H_2 L^{-1} h^{-1}]
Small organic acids
Biomass

CATTCAATTTGCAGCGTTCCTAAAATGGCAAGCACAACGCTGCTCCAGCCCGCGCTTGGTCTGCCCTCGCGGGTAGGG
CCTCGCTCCCCTCTGTCGCTTCCCAAAATTCCTCGCGTGTGCACGCACACTAGTGCTCCCTCTACCTCAAAGTACTGC
GACTCATCATCAGTTATAGAGAGCACGCTAGGGCGGCAAACATCGGTTGCCGGGAGACCATGGCTTGCACCCCGGCCT
GCGCCTCAACAAAGCCGAGGCGACCTACTGGTCTCCAAATCGGGGGCAGCAGGAGGCATGGGCGCCCATGGAGGGGGC
TTAGGGGAACCGGTCGATAATTGGATCAAGAAGCTACTCGTTGGTGTCGCGGCGGCGTACATCGGCTTGGTCGTGCTG
GTGCCCTTCCTGAATGTCTTCGTCCAGGCGTTCGCCAAGGGCATCATTCCCTTCCTGGAGCACTGCGCGGACCCGGAC
TTTCTGCACGCACTCAAGATGACGCTGATGCTGGCGTTCGTGACGGTGCCGCTCAACACGGTGTTTGGCACGGTGGCC
GCGATCAACCTCACGCGCAACGAGTTCCCCGGCAAGGTGTTCCTGATGTCGCTGCTGGACCTGCCCTTCTCCATCTCG
CCCGTGGTGACTGGCCTGATGCTCACGCTGCTGTACGGCCGCACCGGCTGGTTCGCGGCGCTGCTGCGGGAGACCGGC
ATCAACGTGGTGTTCGCATTCACGGGCATGGCCCTGGCCACCATGTTTGTGACGCTGCCGTTCGTGGTGCGCGAGCTG
ATCCCCATCCTGGAGAACATGGACCTGTCGCAGGAGGAGGCGGCGAGAACGCTGGGGGCCAACGACTGGCAGGTGTTC
TGGAACGTGACGCTGCCCAACATCCGCTGGGGCCTGCTGTACGGCGTGATCCTGTGCAACGCCCGAGCCATGGGCGAG
TTCGGAGCCGTGTCCGTCATCTCGGGCAACATCATCGGCCGCACGCAGACGCTGACGCTGTTCGTCGAGTCCGCCTAC
AAGGAGTACAACACGGAGGCGGCGTTCGCGGCGGCTGTGCTGCTGAGCGCGCTGGCGCTGGGCACCCTGTGGATCAAG
GACAAGGTGGAGGAGGCGGCGGCGGCGGAGAGCCGCAAGTAGAGAGGAGCAGGCGGCGTCGGCAGCGGCGGCAGTGGC
AGCGGCAGCGGCGGAGAGCGGCAGCTGGAGAGGAGCAGGCGGTGGCGGCGGAGCGGCGGAAATAGAGAGGTGCAGCAA
GGAGGCAGGCGCCGACGCGAGGGGAGGGCGTGGTGGTGGGCTTGCGTGGGTGCTTGGTCCGTGGCCAGGGTGCCTGGC
CTGGGTAGTTGGTGTGTGGGTGAAGCTGATTCCTGTTTGGGTGAGGCGGCCGAGTTCCTGAAGGAAGCAAGGAAGGAC
AGTGCCGCAGTGACCAGCGGGTAATGGTAAGGGAGCTGACACGTGTGGCGTTCTGTTGCTGGTCGCCGCATGCTTAAC
GCAGCGGGAGCAGCTTCTCTGTCTGATGTCTAACGGGGGCGTTGTATGCTGATAATAGACGGAGGGCGAAGGGAGCAG
GCGCGGTTCAGATGGGGTAAAAGCTGTTGGAAATCAACACGTGCAGCGGGTGGGTTGCATTTGTGATCACTGGACGTT
CTGAGTGGTCCGTGCGCCTATAGCGCGTGCTGTGCATATATACGCGCGCCGGCGCATAAAACATGACTGCATGTGTCG
GTGTTGACGGTACAGTTATGCCGTGCCCCGTTTTACAAGCGGGATAGAGGCACACTCCACGTAGTATGCATTGAGCCC
AGTAGACTCTGGTCAGAAGGCCGGTAAATTTACATGTGTCGTGGTGAACCCTGTAAGTCATGGCCCAAG
(SEQ ID NO: 04)

FIG. 21

GTACTTCAATTGTCAGAATGGCGTCGCTGCTCGCTCAAACAACATCGCGCCTTGGCGCTCGCCCAGCTGCGCAA
GCTGGCCCTGTCGCCCAAATGGCACCGATGGCAAGCCGAGTGCAGCCGGCGATGCCTAGCGCGCTGCTCCCACT
GCACGCCAGAGCGACAACAACTTCAGTCGCTTGCCGGGCAGCCAGCATCGACAAACCTGTCGTTTACACTCCTC
GAGATTCGTCGCAACAGTCCTCCAATGGGGCAGGAGAAGTGTCCATGTCCATATCATCCATGGACGAGGTTGGA
CCCTCTTATGAGGGAATCATTACAGACGCGCCTACACGACCAACGGGGCTTTATGTGCGGGTGCGCAACATGGT
GAAGCACTTCAGCACCGCCAAAGGCCTGTTCAGGGCGGTGGACGGCGTGGACGTGGACATCGAGCCCAGCTCCA
TCGTGGCGCTGCTGGGGCCCAGCGGCAGCGGCAAGACCACATTGCTGCGCCTCATTGCAGGCCTGGAGCAGCCC
ACGGGCGGCAACATCTACTTTGACGACACGGACGCGACCAACCTGTCCGTCCAGGACCGCCAGATCGGCTTCGT
GTTCCAGAGCTATGCGCTGTTCAACCACAAGACAGTTGCGGAGAACATCAAGTTTGGACTGGAGGTGCGCAAGC
TCAACATCGACCACGACAAGCGCGTGGCGGAGCTGCTGGCGCTGGTGCAGCTCACCGGCCTGGGCGACCGCTAC
CCGCGCCAACTGTCGGGCGGCCAGCGGCAGCGTGTGGCGCTGGCGCGCGCCCTGGCCTCCAACCCGCGGCTGCT
GCTGCTGGACGAGCCCTTTGGCGCGCTGGACGCGGTGGTGCGCAAGCAGCTGCGCACGGGGCTGCGCGAGATCG
TGCGCAGCGTGGGCGTGACCACCATCATTGTGACGCACGACCAGGAGGAGGCGTTCGACCTGGCGGACAAGGTG
GTGGTGTTCAACAGGGGCCTGGTGGAGCAGCAGGGCAGCCCCACCGAGATCATCAAGCGGCCGCGCACGCCCTT
CATTATGAAGTTCGTGGGCGAGACCAACGTGGTGCCGGCCACGTCGCTGCTGGCCAAGCGCATGCGCTTCAACA
CCTCCAAGACCAGCGTCATGTTCCGGCCGCACGACATTAAGCTGTTCAAGACGGTGCCGCCGGAGAGCGGCGAG
GGCGCGCTGACCACGGTGGGCGCCAACGTGGCGGACAAAGCCAACCTGGGCTGGGTGGTCAAGTACACGCTGCG
CTTCGATGACGACGTGGAGTGCGAGCTGCAGCTCAGCCGCGACCAGGACGAGCGCGAGTACAACCTGGTGGTGG
GCAGCCGCGTGTTCGTGCACGTGCCGCACCGCACCATGATGGGCTTCAACGCCAGCGACGTGGACAGCACGCCC
ATCGTGTAATGTGCGGGGTTGGCGGCTGTGGCCAGCGATTGTTGCAATGCAGTCCAGCGTGCTCTTGGTTTGGT
TCCAGTGACACCCATCCAGGGCACAGGTCCCTGAGCAGCGGGTGTTGGTGATGGGTTGGAGCAGTTGTACCCGA
TTCTCGCATGCAAGGGGGCGGGGCGCCCACGGGGTGGGAGAGCGGAATGGCGGTGAGGTGGGCTACTGCATGCG
GCCGTGGAGGAACGGAGGGGTGCACAGGCGGGCAGGTAGACAGGCGGAGCGGGCTGGGTGAGCGGGGCTGTAGT
TTGGGGGTGGAGGCCGTGCAGACTGGTTGGGATACTGACAGATCAATGAGCGGCGTCTGCTCCATGGGTCAGTA
GGAGAGCGGTGTGGGTGTGTGCAGTTGCGAGTTCTGGAGCGTTGTGCGCCTCGCGCTGTGTGCGCGCGCCCGTG
CGTCTGCGGGCGCTGTCGGAGACGGGCGATGTACATGAAGCTGGACCTGGGCCTGTCTCACAAATATCCCTTAT
GTTAATAGTAGGATGTCGCAATCGTGCCTTGGAGCCCACCTGATGTGTGTGTCACAGGTGGCAGTAGTTTGGCC
TTGCGGGAGGTAGCACGTCTTTCATGAGAGTGCGTGTGCGTGACCGCTTTTACATTGCCAATCACGCTGGAAGG
TGAAACCATGCATCATGCGTGCTATCAGGAGATGCAGACGGCGGATTGCTGCCAAAATGTTCTGTTGTTGGTGT
GCAGACTTGGTGGCGAAGGGGCCAGGCGCCCAGGGGTATGCTGCGTGCCAAGGAGCTGCTGCCGCCACGAGTGA
CCAGCGAAACTTGTAAATTGAATATTGTATCCT (SEQ ID NO: 05)

FIG. 22

GGGCAGCGTATAAGTAATGTCGTTCTTGGCTCCCAGCTTAGGCGTCGCGCGGGGGATTCTGGAGCCGGCGAGTGC
AGCGAGGCCGCCTGCGCACGCGGCCGGTCACGCACCCGTTCTAACAAGCGATAGGACTGGTGGACCTGCCGCTAA
TCATGACAGGCCTGCCGGTGCTCCCAGCCCCCATGCGGCGTCGTTGACGCCCTCCAGCAGCGGGCAAGCAAGCCA
GCAAGGCGACCCCCAGCGCTCGCAGCACCAGCAAGCGCAGCGCCAGGACCAGCAGCAGTCGCAGTCGCGGTCGCT
CCAATCACACCTCATCACCGCGGCCACGCTGCTGCCAGCCCTGCCGCCTCCGCCTCCCGGCGGCAACGGCGACGG
CGATGGCGGCGAAGCTGCGGGGCCGCAGCCGCTCGCGGACGTCGCGGCTCAGCCGCCGGAGGTTGTGCTGACGCT
GGCGTCGTTCGCGGTGACCAAGCTGGCGTACGTGCGTGTGACGCGCGCGTTCCGGGAGTGGTACGAGCGCACGAA
GGGCGTGGATGTGCGCTTCCGCCTCACCTTCGCCGCCAGTGGCGTGCAGGCCCGCGCCGTGATCGATGGCCTGCC
CGCCGACATCGTGGCCCTGGCGCTGCCTCTGGACCTGGACAAGATCGTGTCGGCGGGGCTGATCCGGCCCGACTG
GCGCAGCGCCTACCCGGCAGCCAGCGTGGTGTGCGAGACCACCGTGGCGTTCGTGGTGCGCCAGGGCAACCCCAA
GAACATCCGCACCTGGGAGGACCTCACGCGGGCGGGTGTGGAGGTGGTGCTGGCCAACCCCAAGACCGCCGGAGT
GGCCAGGTGGATCTTCCTGGCCCTGTGGGGCGCCAAGATGAAGAAGGGCAACGCCGCCGCGCTGGCGTATGTGCA
GCGCGTGTTCGAGAACGTGGTGGTGCAGCCGCGTGATGCGCGCGAGGCGTCGGACGTGTTCTATAAGCAGAAGGT
GGGCGACGTGCTGTTGACGTACGAGAACGAGGTGATCCTGACCAACGAGGTGTACGGCGACAAGGCGCTGCCGTA
CCTGGTGCCCTCCTACAACATCCGCATCGAGTGCCCGCTGGCGCTGGTGGACAAGGTGGTGGATGCCCGCGGCCC
CGAGGTGCGCGAGGCGGCGTCCGAGTTCTGCCGTTTCCTGTTCACGCCCGCGGCGCAGCACGAGTTCGCGCGGCT
GGGCTTCCGCGTGAACCCGCGCACCTGCAAGGAGGTGGCGGCGCAGCAGACCGGACTGCCGCCCGCAAACCTGTG
GCAGGTGGACAAGGAGCTGGGCGGCTGGGCTGCGGCCCAGAAGAAGTTTTTCGACGCTGGCGCCATCCTTGACGA
CATCCAGTCCGCCGTGGGCAAGCTGCGTGTGGAGCAGCGCAAGGCGGCGCAGGCGGCGGCCAGGCGGTAGAGAGA
CGCGGTACAAGTGCTCGGGTGCTCAGCAGGAGCTGCAGCAGGGGCAGCAAGAGGGCCTTGACAGGAGGGAATGGT
AGGCAAAGGCGGCAGGGGAGGCGGGATGGCGGGATGAAGTGAGGGTGTGCAAGCAGCGATGTGTGCCAAGGACGG
TGTCGGCGATGTACATGATAACATGAGGAGACAGGAGCATCTCCTGGCAGGAGGCGGCAACCGTGGAGTGTCTGA
AAGGAGAACTTGATTGCTCAGTGTGGGACAGATAACGGAGGGCGGGGTGTGGGGCGTGGGGCTTATCGGTGTGCT
TCTATGGGGAGGCCTGACTGCATTGGGGGCGACGTAGTGTGATGGCCGCTACACGCTTGCTCGGAACTGACATAA
ACAGGCGTTCAGGCCATGGCTGCATGAGGCTTGATGTCGTATCGCGGACTGTC (SEQ ID NO: 06)

FIG. 23

MASTTLLQPALGLPSRVGPRSPLSLPKIPRVCTHTSAPSTSKYCDSSSVIESTLGRQTSV
AGRPWLAPRPAPQQSRGDLLVSKSGAAGGMGAHGGGLGEPVDNWIKKLLVGVAAAYIGLV
VLVPFLNVFVQAFAKGIIPFLEHCADPDFLHALKMTLMLAFVTVPLNTVFGTVAAINLTR
NEFPGKVFLMSLLDLPFSISPVVTGLMLTLLYGRTGWFAALLRETGINVVFAFTGMALAT
MFVTLPFVVRELIPILENMDLSQEEAARTLGANDWQVFWNVTLPNIRWGLLYGVILCNAR
AMGEFGAVSVISGNIIGRTQTLTLFVESAYKEYNTEAAFAAAVLLSALALGTLWIKDKVE
EAAAAESRK* (SEQ ID NO: 07)

FIG. 24

MASLLAQTTSRLGARPAAQAGPVAQMAPMASRVQPAMPSALLPLHARATTTSVAC
RAASIDKPVVYTPRDSSQQSSNGAGEVSMSISSMDEVGPSYEGIITDAPTRPTGL
YVRVRNMVKHFSTAKGLFRAVDGVDVDIEPSSIVALLGPSGSGKTTLLRLIAGLE
QPTGGNIYFDDTDATNLSVQDRQIGFVFQSYALFNHKTVAENIKFGLEVRKLNID
HDKRVAELLALVQLTGLGDRYPRQLSGGQRQRVALARALASNPRLLLLDEPFGAL
DAVVRKQLRTGLREIVRSVGVTTIIVTHDQEEAFDLADKVVVFNRGLVEQQGSPT
EIIKRPRTPFIMKFVGETNVVPATSLLAKRMRFNTSKTSVMFRPHDIKLFKTVPP
ESGEGALTTVGANVADKANLGWVVKYTLRFDDDVECELQLSRDQDEREYNLVXGS
RVFVHVPHRTMMGFNASDVDSTPIV* (SEQ ID NO: 08)

FIG. 25

MSFLAPSLGVARGILEPASAARPPAHAAGHAPVLTSDRTGGPAANHDRPAGAPSPH
AASLTPSSSGQASQQGDPQRSQHQQAQRQDQQQSQSRSLQSHLITAATLLPALPPPP
PGGNGDGDGGEAAGPQPLADVAAQPPEVVLTLASFAVTKLAYVRVTRAFREWYE
RTKGVDVRFRLTFAASGVQARAVIDGLPADIVALALPLDLDKIVSAGLIRPDWRSA
YPAASVVCETTVAFVVRQGNPKNIRTWEDLTRAGVEVVLANPKTAGVARWIFLAL
WGAKMKKGNAAALAYVQRVFENVVVQPRDAREASDVFYKQKVGDVLLTYENEV
ILTNEVYGDKALPYLVPSYNIRIECPLALVDKVVDARGPEVREAASEFCRFLFTPAA
QHEFARLGFRVNPRTCKEVAAQQTGLPPANLWQVDKELGGWAAAQKKFFDAGAI
LDDIQSAVGKLRVEQRKAAQAAARR* (SEQ ID NO: 09)

FIG. 26

FIG. 27

Chloroplast Sulfate Transport System